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April 22, 1997

Dr. Joseph Kravitz, Program Officer
Office of Naval Research - Code 322GG
Department of the Navy
Ballston Centre Tower One
800 N. Quincy St.
Arlington, VA 22217-5660

Re: PERFORMANCE/FINAL TECHNICAL REPORT for -
Enhancing Shallow Seismic Reflection Profiles using
Nonlinear Correlation: Applications to the New Jersey Margin
Grant No. NOOO14-95-1-0057

Dear Joe:

We enclose our Performance/Final Technical Report concerning the above-mentioned grant. Copies have also been sent to the individuals listed below, as outlined in the Grant Schedule.

If you require any further information, please do not hesitate to contact me at 914-365-8540, or via email: mountain@ldeo.columbia.edu.

We thank the Office of Naval Research for this award.

Very truly yours,

Gregory S. Mountain
Senior Research Scientist

enclosures

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ONR Grant No. NOOO14-95--1-0057
R & T Project : 22ga244---01

Performance/Final Technical Report

Enhancing Shallow Seismic Reflection Profiles using Nonlinear Correlation: Applications to the New Jersey Margin

Gregory S. Mountain, Peter Buhl

The upper 200 m of the sedimentary section of the New Jersey Margin are poorly resolved on older multichannel seismic (MCS) images; in particular, on MCS data collected during Cruise 9009 of *R/V Maurice Ewing*. The object of this survey was to image deeply buried stratigraphic sequences (200 - 1000 m below the sea floor) which record the history of Oligocene to Miocene sea level changes. To insure adequate signal-to-noise ratio during the rough weather encountered, a large initial offset (200 m) was used between the airgun source and the initial hydrophone receiver group. In the shallow water of the continental shelf (~100 m and less) this initial offset meant that reflecting rays from the upper 200 m arrived at large angles from the vertical. The positive velocity gradient in the sediments exaggerated the convergence of the reflections from various depths, and caused these reflections to cross one another at or shortly after the near-offset channel.

To properly image the sedimentary structure, the MCS technique depends on the ability to correct the traveltime of all reflections to zero offset, in a process called the normal moveout (NMO) correction. Due to severe reflector convergence that occurs in large-offset, shallow-water operations, this correction results in extreme stretching and distortion of the part of the near-channel recording that contains shallow reflections. This contributed further to the poor images of the upper 200 m.

Nonlinear Correlation techniques have proven useful in interpolating seismic traces, (Martinson and Hopper, 1992). These techniques allow a mapping of two distinct time series, one of which has had its time scale variably stretched and/or compressed throughout its length. The mapping function provides a rigorous interpolation of intermediate examples of the two-time series. For nearby seismic traces this mapping function is very exact, as the traces are quite similar. Difficulties arise, however, when this method is used for extrapolation, since extrapolation is much less well constrained than is interpolation. Extrapolating sequences of traces to zero offset is what is required to generate the proper seismic image. However, our analysis showed that the particular velocity-depth function of the NJ Margin produces reflector crossovers near the initial offset trace. Coupled with the trace stretch, we found that extrapolation produces poor images. It became clear

that despite our efforts, nonlinear correlation technique **cannot** be used to enhance images of the shallow sedimentary section from the EW-9009 MCS data.

The required solution to this shallow imaging problem is to shorten the initial offset to approximately one-half the water depth. This was done for the data collected in 1995 during *Oceanus Cruise 270* in support of the Strataform Project. These new data show excellent images of the upper 200 m, confirming this conclusion.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
Enhancing shallow Seismic Reflection Profiles using Nonlinear Correlation: Applications to the New Jersey Margin

5. FUNDING NUMBERS
Grant No.
N00014-95-1-0057

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The Trustees of Columbia University in the City of NY
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8. PERFORMING ORGANIZATION REPORT NUMBER
#5-21627

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Office of Naval Research
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Arlington, VA 22217-5660
(Dr. Joseph H. Kravitz, Scientific Officer)

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
R & T Project: 22ga244---01

11. SUPPLEMENTARY NOTES
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12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Some older Multichannel Seismic data recorded on the shallow continental shelf do not properly image the upper few 100 m. This is due to a large (approx. 200 m) minimum source-receiver offset. Nonlinear Correlation, used successfully for other seismic processing was not able to correct the data. The use of a short (Approx. 30 m) minimum source-receiver offset produces excellent seismic images of the upper sediments.

14. SUBJECT TERMS
Nonlinear Correlation - Application to New Jersey Margin

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL